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Assessing the feasibility of mobilisation of C0–C3 cervical segments to reduce headache in migraineurs

Ian Davidson, Kathryn Crooks, Lisa Newington, Mark Pilling, Christopher Todd

Abstract

Background: Migraine headache poses a major public health problem. Pharmacological treatment is the most common management strategy, however patients are increasingly seeking alternative treatments. The Watson Headache® Approach (targeted and sustained non-manipulative mobilisation on C0–C3) is used to reduce headache symptoms and provide sustained relief. This research aimed to assess this approach as a treatment strategy for migraine headache and to provide data to inform a subsequent randomised controlled trial.

Methods: One-hundred-and-one migraineurs were randomised to either the 'treat now' ($n=54$) or 'wait list' ($n=47$) group. Physiotherapists trained in the approach provided the intervention. Participants received six sessions. Outcome data were collected as a headache diary, including: headache score, headache days, headache duration, pain and medication use. Follow up was immediately post treatment (FU0) and at 3 (FU3), 6 (FU6) and 12 months (FU12).

Results: Between-group analysis found no difference between the wait list group at baseline 2 and the treat now group at FU0 for any of the variables of interest. Within-group analysis found that after treatment participants experienced a reduction in headache intensity ($P=0.007$) and duration ($P<0.001$), had fewer headache days/28 days ($P<0.001$), hours of severe migraine headache ($P<0.001$) and used 20% fewer medications compared with before treatment ($P<0.001$).

Conclusion: The Watson Headache® Approach shows promise as a potential strategy for migraine management, however further work is required to assess the efficacy of this technique in a larger, randomised placebo-controlled trial. Future studies should aim to identify those most likely to benefit from treatment and who may be at risk of potential adverse event.

Key words: ■ Migraine ■ Headache ■ Watson Headache® Approach
■ Cervical mobilisation ■ Physiotherapy

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Migraine headache poses a major public health problem, both economically (Bloudek et al, 2012; Berra et al, 2015) and socially (Le et al, 2011; Winter et al, 2012; Chu et al, 2013; Stewart et al, 2013). Eleven per cent of people worldwide suffer from migraine headaches (Stovner et al, 2007). Migraine prevalence is highest between 25 and 55 years (Lipton and Bigal, 2005) and peaks at age 40 (Hazard et al, 2009). The condition is three times more common in women (Schwartz et al, 1998). Work

function may be affected, with reduced performance accounting for >75% of lost productive time (Stewart et al, 2008).

The 2013 International Headache Society classification describes primary headaches (migraine, tension type headache and trigeminal autonomic cephalalgias). It also provides comprehensive definitions of headache types and diagnostic criteria for >300 headaches. Although the categorisation of headache types might suggest different causative factors, a 'continuum' of headache has been

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hypothesised linking migraine to tension type headaches (Featherstone, 1985; Nelson, 1994; Bronfort et al, 2001; Cady et al, 2002; Bartsch, 2005). It has been further postulated that migraine headache may have its origins in the cervical spine (Bartsch and Goadsby, 2003; Bartsch, 2005).

The neuroanatomical basis for migraine headache as cervicogenic may rest with the convergence of nociceptive afferents from the receptive fields in the upper three cervical nerves within the trigeminal nerve field (Bogduk, 2001; Bartsch and Goadsby, 2003). Should a continuum exist between migraine, tension type headache and cervicogenic headache, the causative mechanisms could be shared. The basis for the physical treatment for cervicogenic (Dunning et al, 2016) and tension type headache (Linde et al, 2016) has been made. If the same treatment linkage could be demonstrated for migraine headache, this would strengthen the case for accepting the continuum theory.

Most headache treatment is self-care (Boardman et al, 2003) through medication (Vickers et al, 2004). However, many pharmaceutical treatments are suboptimal (Linde et al, 2005) and, in cases of medication overuse, can augment headache (Colás et al, 2004). Consequently, many patients seek non-pharmacological solutions, such as acupuncture or manipulative therapy (Bronfort et al, 2001; Astin and Ernst, 2002; Schabert and Crow, 2009).

Systematic reviews of trials (Bronfort et al, 2001; Astin and Ernst, 2002) comparing spinal manipulative therapy (chiropractic and osteopathic) with various other modalities show limited evidence of the effectiveness in the amelioration of various headache types, including migraine.

Reproduction of familiar headache for migraine and tension type headache using sustained spinal mobilisation has been demonstrated by Watson and Drummond (2012). Using targeted and sustained (non-manipulative) mobilisation techniques on the C0–C3 segments, Watson (2011) has claimed reproduction and lessening of familiar headache or migraine symptoms (with and without aura) and would expect appreciable relief from symptoms within five treatments. These claims have, until now, remained untested within the context of a pragmatic clinical trial.

STUDY AIMS

- To observe the impact of targeted mobilisation of C0–C3 segments on the intensity, frequency and duration of headache, including migraine (with and without aura), in migraineurs.
- To provide within-subject data to inform the size of the treatment effect in order to provide an

accurate power calculation for a future randomised controlled trial (RCT).

- To provide between-subject pilot data to assess the feasibility of a 'wait list' methodological approach that could be used in a future RCT.
- To assess the acceptability of the approach for a migraineur population.

METHODS

Study design

A wait list RCT was conducted in which participants were randomised to receive treatment immediately ('treat now' group) or delayed intervention ('wait list' group). Both groups provided baseline data (BL1) at recruitment. The intervention (treat now) group then proceeded to receive treatment over a period of 3–6 weeks. Outcome assessment was conducted 28 days (4 weeks) after treatment completion (FU0) with subsequent follow-ups at 3 (FU3), 6 (FU6) and 12 (FU12) months. The wait list group experienced a time delay before treatment during which it acted as control. The wait list group completed a second round of outcome measures 4 weeks prior to receiving any treatment. This provided data to compare with the FU0 outcomes for the intervention group and acted as a second baseline (BL2) for the wait list controls in order to assess steady state. Within-group comparison permitted estimation of effect size and helped inform a sample size estimate for any future definitive RCT. At each data collection point, the data were combined for within-group analysis of treatment effect comparing BL1 with each data follow-up point. All follow-up data were collected by postal administration of self-report outcome measures. The study design is summarised in *Figure 1* and the protocol in *Figure 2*.

The study was approved by the NHS NRES Manchester Central Ethics Committee (number 06/Q1407/86).

Patient recruitment

Once potential participants had consented, they were contacted by telephone for assessment against the entry criteria, see *Box 1*. Most had received a previous diagnosis of migraine from either a neurologist or GP. After eligibility was confirmed against the International Headache Society diagnostic algorithm for the existence and nature of migraine, eligible participants were sent a battery of baseline measures to complete (BL1).

Headache-specific outcome measures

Twenty-eight day headache diaries were posted to participants for completion at home. Data were

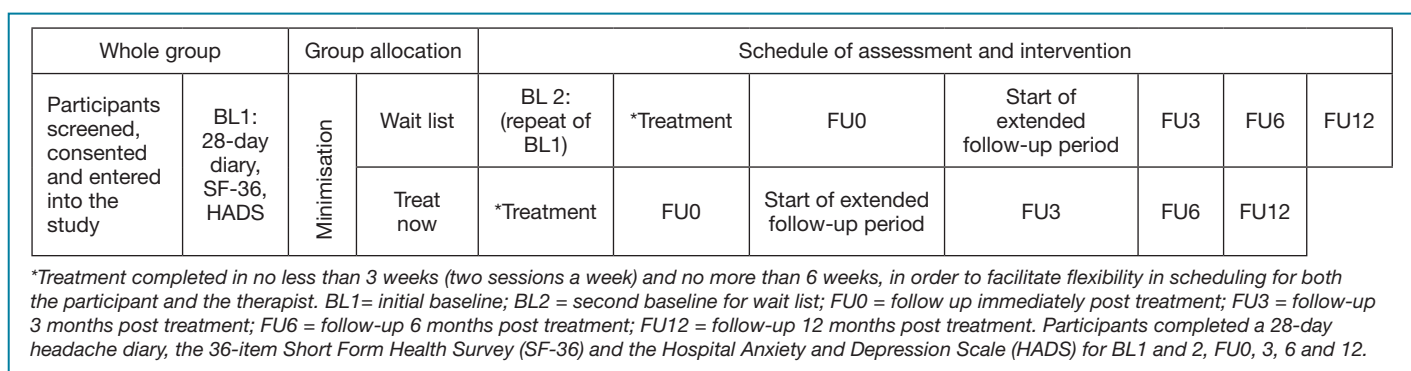


Figure 1. Study design including the schedule for the assessment and intervention

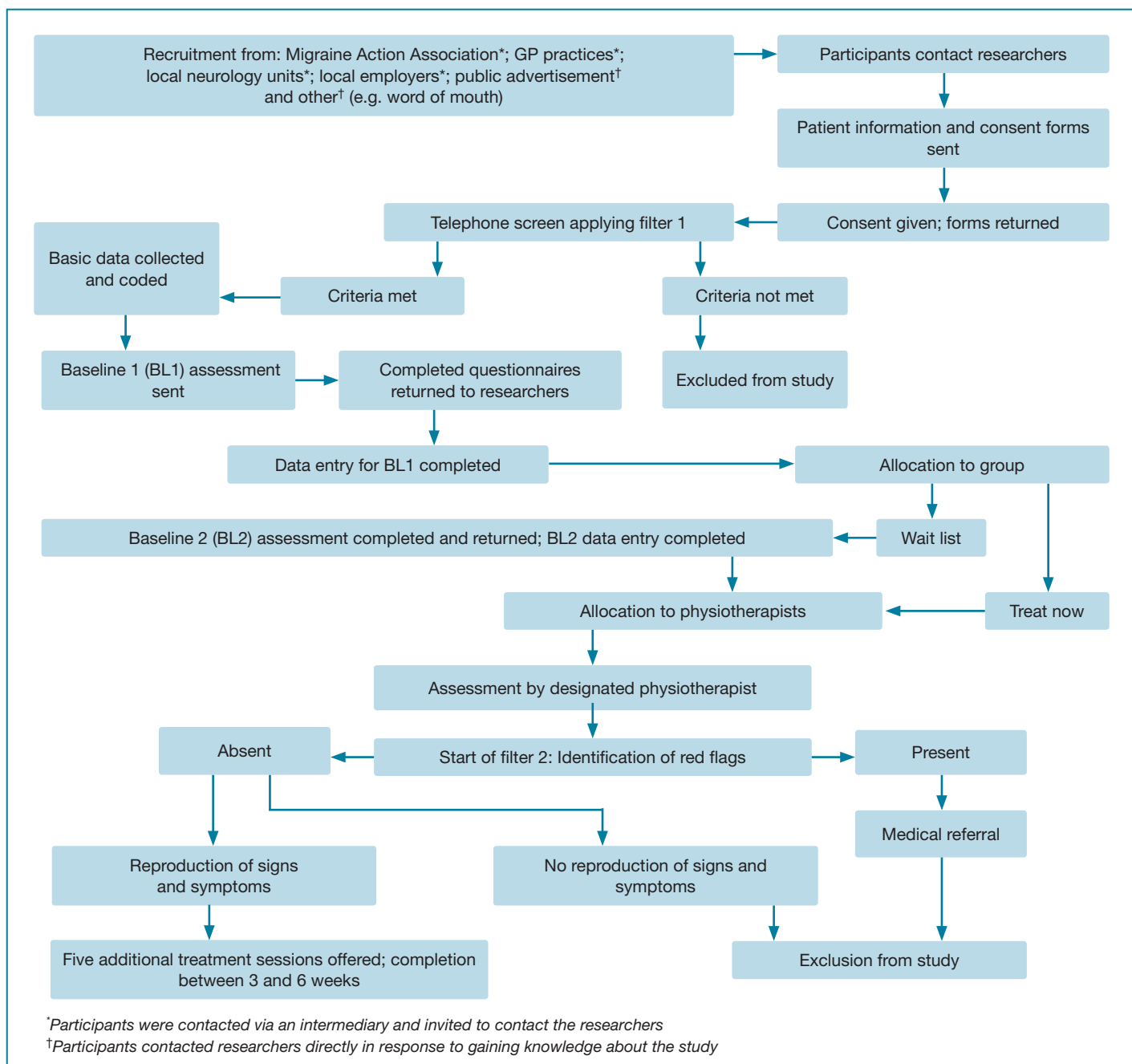


Figure 2. Study protocol flowchart

Box 1. Inclusion and exclusion criteria assessed at recruitment interview

Inclusion criteria

- Aged ≥ 18 years
- Meet the criteria for diagnosis of migraine headache (International Headache Society classification 1.1)

Exclusion Criteria

- Onset of headache disorder < 1 year
- Onset at age ≥ 50
- Pregnancy
- Cerebral or cervical malignancy
- Physiotherapy for headache or cervical conditions within the previous 12 months
- Participation in any health-related research projects within the previous 12 months

collected at baseline (BL1), immediately post-treatment (FU0) and then at 3 (FU3), 6 (FU6) and 12 months (FU12) post treatment. The wait list group had an additional baseline assessment (BL2) prior to receiving intervention, then follow-up assessments at 0, 3, 6 and 12 months following treatment, see *Figure 1*. The diary included the following outcome measures:

- The headache score (headache severity) (Vickers et al, 2004)
- Headache days (converted into number of days with one or more headaches every 28 days)
- Duration of headache (hours)
- Number of hours of migraine headache
- The frequency at which a headache-related medication was used. (Participants were advised to continue their normal medication regimen.) Dose was not recorded and only medications related to headaches were recorded (triptans, painkillers and anti-inflammatories).

While the study collected data on all headaches, a reported headache score of 4 ('I find it difficult to concentrate and can do only undemanding tasks') and 5 ('Intense, incapacitating headache') were reported as severe migraines (Vickers et al, 2004). This has face validity and broadly correlates with qualitative reports of 'migraine' in the headache diaries.

In addition, a quality of life questionnaire, the 36-item Short Form Health Survey (Brazier et al, 1992) and the Hospital Anxiety and Depression Scale (Zigmond and Snaith, 1983) were completed at baseline and posted back to the lead researcher. The effects of headache on work, domestic and social activities were recorded together with a pain visual analogue scale. These data are not reported in this paper.

Allocation of participants

Consecutive sampling was used; all those who met the entry criteria were eligible for the study. Once BL1 data collection was completed, participants were allocated to the treat now or wait list groups by minimisation (Treasure and MacRae, 1998). The minimisation factors were age, sex, diagnosis (migraine with and migraine without aura), headache score at baseline and number of years of headache disorder (chronicity). Allocation was done by the chief investigator (ID) using the MINIM software package (Evans and Day, 1995), which did not allow subsequent changes to be made. The allocation was then passed to the research assistant(s) (KC and LN) for processing.

Intervention

Allocation to physiotherapist

Three physiotherapists working in private practice in different geographical locations in the North of England participated. All had attended the 2-day Watson Headache® Approach course and were using this technique in clinical practice. Once allocated to receive treatment, the participant was able to choose which of the physiotherapy practices he or she wanted to attend.

At the initial session, the physiotherapist screened for red flag symptoms and whether participants' familiar headache (with or without aura) could be reproduced by applying specific, skilled pressure to the cervical spine as described by Watson and Drummond (2012). The headache(s) ceased on removal of pressure. If these requirements were met, patients continued with five additional sessions, which had to be completed within a minimum of 3 and maximum of 6 weeks.

The Watson Headache® Approach

This approach (Watson and Drummond, 2012; 2014) is based on the well-established Maitland approach to spinal mobilisation (Maitland et al, 2005). Manual, digital pressure is exerted on bony prominences of the cervical spine, using them as levers to create inter-vertebral movement to normalise range and alignment. Although variation exists in grading, pressures tend to be slow and deliberate; there are no high velocity or thrusting techniques.

A key difference between Maitland's approach and Watson's is the gradation of pressure. Maitland uses oscillating pressures that are graded from 1 to 4, where grade 1 is the lightest pressure and 4 is a low amplitude movement at the end of the available range. Watson predominantly uses sustained (non-oscillatory) Maitland grade 4, pushing into joint resistance (stiffness). The Watson Headache® Approach is also multifaceted, incorporating other interventions such as exercise and advice. Only the cervical mobilisation element was assessed in this study.

Sample size

We estimated the sample size with $\alpha=0.05$ and 80% power using a two-sided paired t-test approach. Using data provided by Vickers et al (2004) and assuming no correlation between the baseline and 12-month scores (the most conservative estimate), for a baseline mean headache score of 24.6 (standard deviation [SD]: 14.1) and a 12-month mean score of 16.2 (SD: 13.7) the required sample size was 45. Allowing an estimated attrition of 30% at 12 months, the sample size for a simple before–after design should be inflated to 65. For a two-group design, a total sample size of 70 (pre-attrition=100) would allow for an assumed weak intraclass correlation coefficient (ICC) of up to 0.016 (design effect=1.5). A total of 50 patients per group was therefore required.

Blinding

It was not possible to blind participants to group allocation. Therapists did not know which group participants were allocated to, but it is possible participants may have broken blinding during a therapy session. Due to staff resourcing, research staff collecting data were not blinded to participant group membership. However, as all outcome measures were administered remotely by post and by self-report diary, there was little opportunity for the introduction of bias.

Analysis

Between-group analysis between FU0 (treat now) and BL2 (wait list) used an independent groups t-test for all stated variables. This was the only randomised control element of the study. A generalised linear mixed effects model was used for between-group assessment of five key variables: mean monthly headache score; mean headache days every 28 days; mean duration of headache; number of severe migraine headaches; and medication use. This maximised the dataset by estimating the correlation/covariance between terms using all available data, thus avoiding the need for interpolation of missing data and post hoc adjustment.

Participants were fitted as a random variable and different covariance structures were examined (those minimising the Akaike information criteria were reported). Model diagnostics were assessed, e.g. normality of residuals, and appropriate transformation of the data was undertaken where required. Only the most recent baseline data were used and time was fitted as an ordinal variable where BL1, FU0, FU3, FU6 and FU12 were -1, 0, 3, 6 and 12 months, respectively. The group*time interaction term was included. Data were analysed using SPSS 21.

RESULTS

The study commenced in September 2007 and ended in July 2012. Trial information was sent to the 626

people who expressed an interest in taking part. The numbers of participants recruited and retained at each stage of the study after enrolment are given in *Figure 3*.

Between-group analysis

Table 1 gives baseline data for the treat now group at BL1 and the wait list group at BL1 and BL2. Minimisation was successful in providing baseline balance for potentially important prognostic variables. There was some variation in all of the dependent variables between BL1 and BL2, with BL2 scores being lower than BL1 (suggesting improvement). This reached a statistically significant level for number of headache days every 28 days. No other variables were statistically significant.

A comparison was made between wait list and treat now groups' BL2 and FU0 data, respectively, for primary and all secondary outcome measures (*Table 2*). Not all participants completed treatment (treat now $n=37/54$ (69%); pre-treatment wait list $n=44/47$ (94%)).

Significantly less medication (-8.36) was used at FU0 compared to BL2 (*Table 2*). The remaining descriptive results in *Table 2* were all in favour of the FU0 group. For example, participants in the FU0 group experienced 10 hours fewer severe migraines than those in the wait list group (BL2) and also had 2 days fewer headaches every 28 days, suggesting less severe and less frequent headaches over all.

Within-group analysis

A combined analysis of the wait list and treat now groups compared data at BL1 with data at FU0, FU3, FU6 and FU12. First-order autoregressive covariance minimised the Akaike information criteria for all mixed effects models, and was used throughout. Results were checked in a sensitivity analysis by using the non-parametric Kruskal–Wallis between-groups test at each time-point and the conclusions were consistent with the mixed models.

Headache intensity

Headache intensity (measured by headache score) did not require transformation before analysis. There was no significant difference due to group ($p=0.8$, as expected), see *Table 3*, or group*time – i.e. there was no difference between the groups at parallel time points – ($P=0.5$, as expected), see *Figure 4*. *Table 3* shows that headache scores were significantly higher at BL1 than at FU0 ($P=0.007$), FU3 ($P=0.019$) and FU6 ($P=0.038$) indicating a reduction in severity at all follow up time point up to FU6. Significance was not reached between BL1 and FU12 ($P=0.117$).

Headache days

Following a square root transformation of data, no significant difference was found between the groups

in the number of headache days overall ($P=0.8$, as expected), or at any time point ($P=0.9$, as expected), see *Figure 5*. There was, however, a significant improvement over time ($P<0.001$) for both groups after treatment compared to BL1, and this reduction persisted for all time points up to and including FU12 (*Table 3*). The mean reduction in the number of headache days every 28 days between BL1 and FU0–FU12 was 3 days, which translates into an additional 36 headache-free days a year for each participant.

Headache duration

Following log transformation (with 1 unit perturbation) of data, there was no significant difference in headache duration (hours) due to group ($P=0.6$, as expected), or group*time ($P=0.7$, as expected), see *Figure 6*. A significant reduction was found in headache duration over time from baseline ($p<0.001$) see *Table 4*. BL1 participants experienced fewer hours of headache after treatment, and this reduction persisted up to and including FU12.

The estimate of the magnitude of reduction was calculated as $\exp(4.3) - \exp(3.6) = 37$ hours. This indicates that post treatment, participants experienced 37 fewer hours of headache compared with BL1. The reduction persisted for at least 1 year, suggesting that 144 hours fewer headache were experienced after treatment.

Severe migraine headache

Following square root transformation before analysis, no significant difference in number of hours of severe migraine headaches (defined as 4 and 5 on the headache score) was found with group ($P=0.9$, as expected), or group*time ($P=0.7$, as expected), see *Figure 7*, but there was a significant change over time ($P<0.001$), see *Table 4*. The estimate of the magnitude of reduction was calculated as $\exp(2.4) - \exp(1.6) = 6$ hours. After treatment, participants experienced 6 fewer hours of headache compared with BL1, and this reduction persisted for at least 1 year. Extrapolated over the year (given that significance was maintained for 12 months), participants experienced 72 fewer hours of severe migraine headache post-treatment.

Medication use

Following square root transformation before analysis, no significant difference was found in mean medication use between the groups ($p=0.5$, as expected), see *Figure 8*, or group*time ($p=0.3$, as expected), see *Table 4*. There was a significant reduction in medication use over time ($p<0.001$), with the estimated magnitude of reduction being $\exp(2.6) - \exp(2) = 6$ medications. This indicates that after treatment participants used six fewer medication doses compared with BL1 and that this reduction persisted for at least 1 year. This represents a reduction

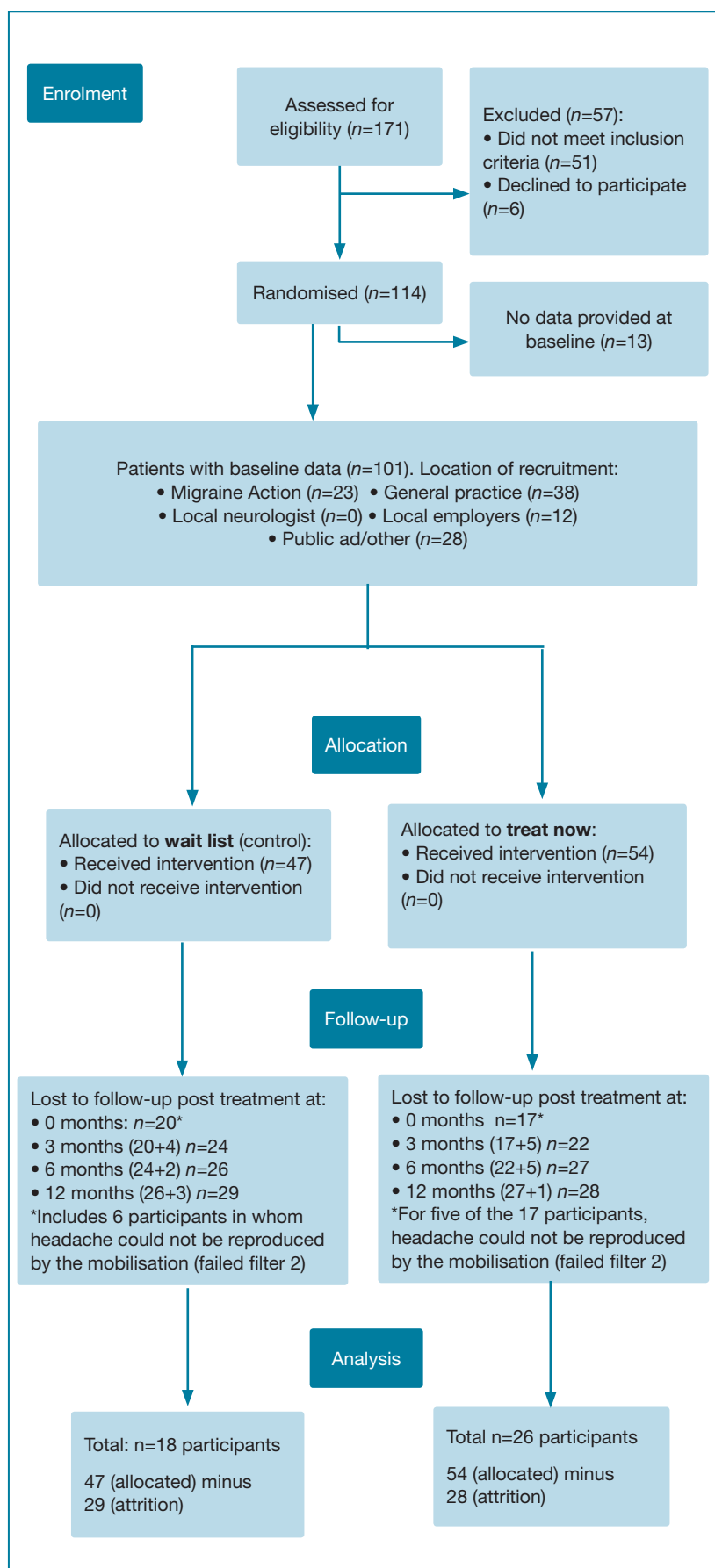


Figure 3. Recruitment and retention of participants during the study

in mean medication use of approximately 20%. Extrapolated over the year, the data suggest that a total of 72 fewer headache-related medications were used per participant post treatment. *Table 4* also reveals an additional and unexpected reduction in mean medication usage between FU3 and FU6 (mean reduction of 2.191 at FU3 versus 1.950 at FU6), which represents a reduction of 27% in mean medication usage between BL1 and FU6.

Sample size for future trial

We used our results to estimate the required sample size for a future trial based on a primary outcome of mean headache score. To allow for the two-group randomised trial design, the ICC was calculated using the difference between mean BL1 and FU12 headache scores and estimating variance components. The mean differences for the treat now and wait list groups were 0.14 and 0.06, respectively, giving $\text{var}(\text{group})=0.06$

Table 1. Summary of baseline data for participants (n=101)

Variable	All participants [†] (n=101)	Treat now (BL1) (n=54)	Waiting list (BL1) (n=47)	Waiting list (BL2) (n=47)
Median age, years* (interquartile range)	46.0 (37.5–54.0)	46.0 (36.8–54.0)	47.0 (38.0–56.0)	47.0 (38.0–56.0)
Female gender* (%)	80 (79.2)	44 (85.0)	36 (77.0)	36 (77.0)
Headache days/28 days (mean) (standard deviation)	12.76 (6.65)	12.00 (6.43)	13.19 (6.94)	11.25 (7.40) ^{§, #}
Migraines per month, hours (mean) (standard deviation)	22.97 (38.16)	23.46 (6.43)	22.40 (40.30)	21.50 (40.25) [‡]
Pain [¶] (mean) (standard deviation)	48.0 (17.8)	46.0 (17.8)	50.0 (17.8)	50.1 (21.5) [§]
Medication use per month (interquartile range)	12.0 (7.0–28.0)	11.0 (6.8–21.0)	16.0 (7.0–32.0)	13.5 (5.3–28.0) [§]
Migraine without aura* (%)	59 (58.0)	31 (58.0)	28 (60.0)	28 (60.0)
Time since diagnosis, years* (mean) (standard deviation)	22.8 (13.4)	23.4 (14.0)	22.1 (12.7)	22.1 (12.7)
Headache score* (standard deviation)	2.63 (0.64)	2.64 (0.63)	2.62 (0.66)	2.60 (0.78) [§]

*Minimisation factors; [†]this column represents combined data for both groups (TN and WL) at BL1; [#]p=0.027 (95% CI: 0.21–3.29) between BL1 and BL2 for related samples t-test; [§]n=44; [‡]n=43

Table 2. Between-group differences comparing the treat now group at FU0 and the wait list group at BL2

Variable	Group	Mean (standard deviation)	Mean differences FU0 – BL2	P-value	95% confidence interval
Hours of severe migraine (4 and 5 on the headache score)	Treat now (n=37)	11.5 (20)	-10.03	0.17	-24.55 to 4.49
	Wait list (n=43)	21.5 (40.3)			
Mean headache score	Treat now (n=37)	2.3 (0.9)	-0.32	0.91	-0.7 to 0.05
	Wait list (n=44)	2.6 (0.8)			
Headache days/28 days	Treat now (n=37)	8.9 (6.9)	-2.33	0.15	-5.51 to 0.85
	Wait list (n=44)	11.3 (7.4)			
Headache duration (hours/month)	Treat now (n=37)	67.1 (74.2)	-12.88	0.45	-46.36 to 20.60
	Wait list (n=44)	80.7 (76.4)			
Medication use (number/month)	Treat now (n=37)	10.3 (9.9)	-8.36	0.009*	-14.56 to -2.51
	Wait list (n=44)	19.9 (18.1)			

and $\text{var}(\text{error})=0.65$. Taking a mean group size of 22 at FU12, an ICC of 0.15 was obtained, which should be taken into account in sample size calculations if a randomised trial design is used in future.

Attrition effects

Attrition in this study was high. A sensitivity analysis of mean headache score data revealed that 38 patients provided complete scores up to and including FU12

(mean headache score: 2.47) and 63 who did not (mean headache score: 2.72). There was no statistically significant difference ($p=0.058$) between the BL1 scores of those who dropped out and those who did not. There was even less difference between the scores at FU0 (drop-out mean: 2.37; non-drop-out mean: 2.30; $p=0.7$). As such, attrition did not appear to skew the results of the study but did reduce its ability to detect between-group differences.

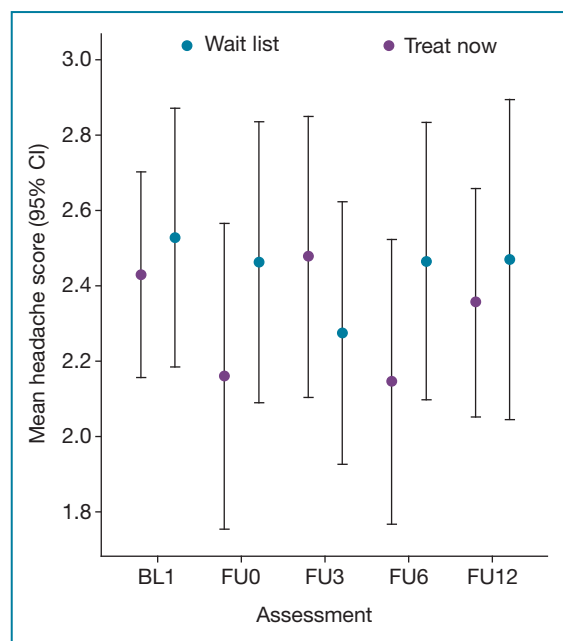


Figure 4. Mean headache scores for the treat now ($n=21$) and wait list ($n=17$) groups

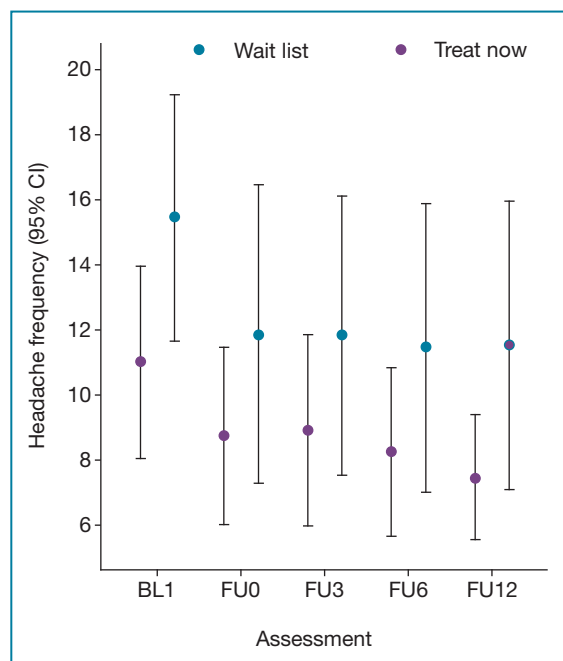


Figure 5. Headache days per 28 days for the treat now ($n=21$) and wait list ($n=17$) groups

Table 3. Time effect: differences from BL1 in headache duration, severe migraine headaches and medication use

Variable	Time point	Mean difference	P-value	95% confidence interval
Headache score	FU0	-0.252	0.007	-0.07 to -0.44
	FU3	-0.255	0.019	-0.04 to -0.47
	FU6	-0.235	0.038	-0.01 to -0.46
	FU12	-0.178	0.117	0.05 to -0.40
Headache days/28 days	FU0	-3.111	0.001	-1.82 to -4.40
	FU3	-2.906	0.001	-1.54 to -4.27
	FU6	-3.803	0.001	-2.55 to -5.06
	FU12	-3.833	0.001	-2.38 to -5.28

Data output taken from a generalized linear mixed model

Table 4. Within-group comparisons of headache duration, migraines and medication use ($n=38$)

Variable	Mean	95% confidence interval
Headache duration (hours)	Baseline	4.275
	FU0	3.668
	FU3	3.764
	FU6	3.575
	FU12	3.715
Severe migraine headaches (hours)	Baseline	2.373
	FU0	1.643
	FU3	1.643
	FU6	1.821
	FU12	1.727
Medication use (number every 28 days)	Baseline	2.618
	FU0	2.093
	FU3	2.191
	FU6	1.950
	FU12	2.155

Data output taken from a generalized linear mixed model

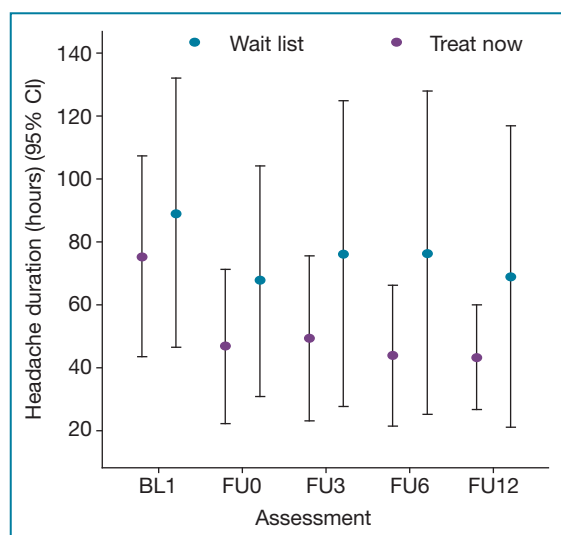


Figure 6. Headache duration for treat now ($n=21$) and wait list ($n=17$) groups

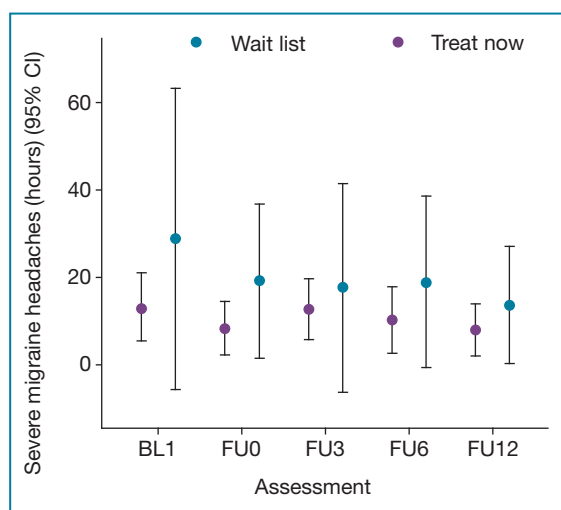


Figure 7. Severe migraine headache in the treat now ($n=21$) and wait list ($n=17$) groups

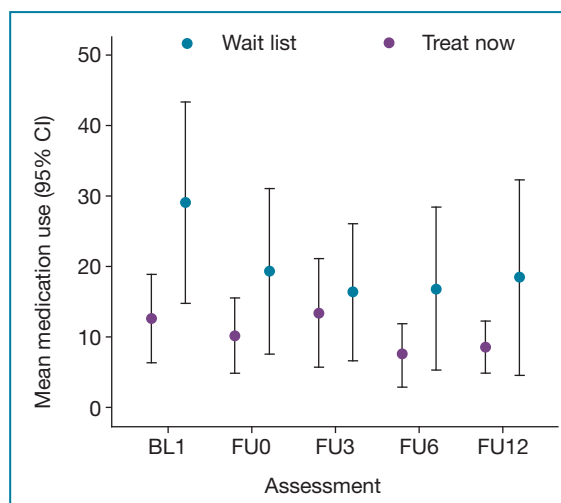


Figure 8. Mean medication use in the treat now ($n=21$) and wait list ($n=17$) groups

Adverse events

Three participants reported adverse events and were removed from the study. Two adverse events were related to an increase in headache frequency and severity. Both participants were men in their early 50s whose migraines had been diagnosed many years before the start of the study. A third person (a female in her early 60s) reported unilateral anaesthesia and paraesthesia in her upper and lower limbs 24 hours post treatment, which resolved within hours. This was not reported to the research team for 7 days. Subsequent medical investigation at the time of report found no neurological dysfunction and she has had no re-occurrence of the symptoms since the episode.

DISCUSSION

Reflecting upon the adverse events, the neurological symptoms experienced by one participant is a particular cause for concern, given the link between migraine and stroke (Malik et al, 2015). Although no cause–effect relationship is presumed, the temporal proximity of the symptoms and treatment is sufficient to advise future caution. Future studies should overtly advise participants that should they experience these symptoms – whether or not in the context of treatment – they should treat it as a medical emergency and seek immediate attention. Despite these unexpected negative aspects of the study, the overwhelming effect of the Watson Headache® Approach on the cohort was positive.

Between-group data did not show any statistically significant differences between the variables tested, except for medication use each month, see Table 2. This statistical difference is equivocal, however, as the wait list group at initial baseline (BL1) had a much higher medication use per month than the treat now group (16; interquartile range: 7–32 versus 11; interquartile range: 6.8–21, respectively), see Table 1. This suggests that the wait list group was more medication-dependent at BL1 and therefore more likely to be so post-treatment. As such, no credible statistically significant difference between groups was seen. However, within-group analysis of the combined data showed a consistent reduction in medication use, which was significant over 12 months. On average, 72 fewer medications for each person a year were used over the 12 months after treatment.

Despite baseline imbalance for medication use, all other potentially important variables were balanced well. Descriptive analysis showed that for all the parameters of interest, there was a substantial beneficial change in favour of the treat now group at FU0 compared with the wait list group at BL2. The lack of statistical difference between the groups may be due to a type II error. This potential issue could be

remedied with the recruitment of larger numbers of participants. Given that an ICC of 0.15 was observed, a much larger study may be required to detect a difference in the primary outcome measure (mean headache score) for this type of staggered design. However, a simpler parallel group design would possibly have much smaller sample size requirements and therefore be preferable.

Overall, within-group analysis showed a much more positive outcome. Statistically significant changes compared to baseline were seen for all follow-up time points up to 1 year except for the headache score, which was only significant up to 6 months. Despite the statistical significance for these variables, the question of clinical significance needs to be addressed. This is a difficult assessment as the significance of any lasting change is a matter of some subjectivity. However, in their study on acupuncture and headache, Vickers et al (2004) estimated that a 35% change in headache score was clinically significant. In their study, acupuncture reduced the number of headache days by a projected 22 days a year. In the present study, the mean difference in headache score was only 0.25 points. Headache duration, number of migraine hours and medication use were all reduced at follow-up but the extent to which these are clinically significant is debatable and requires further analysis. It is unclear whether changes observed can be attributed to the intervention without a control group in the post-treatment part of the study.

It is possible that the clinical effects of treatment could be latent. In this regard, the significant reduction in medication use is of interest due to the problems associated with overuse of painkilling medication (Andrasik et al, 2010; Fontanillas et al, 2010; Kristoffersen and Lundqvist, 2014a; 2014b; Lai et al, 2014). The favoured approach to the treatment of medication overuse is currently withdrawal; however there is no clear consensus on how this should be achieved (Kristoffersen and Lundqvist, 2014a). *Table 4* shows a surprising reduction in medication usage between FU3 and FU6 and beyond the initial reduction seen between BL1 and FU0. If this were to be associated with a reduction in the frequency, duration or severity of headache/migraine, then it would be logical to expect that data collected after FU6 would show an improvement.

Although headache days, duration and severity show no change after FU0, hours of headache for the most severe migraines were unexpectedly reduced between FU6 and FU12. It is possible that these data have unexpectedly captured a relationship linking a reduction in medication use with a reduction in the total hours of the most severe headaches. This is speculative and further analysis of these data will explore whether or not this phenomenon exists. Should this association exist, then it is possible that the

‘Mobilisation of the upper three cervical vertebrae appears to have an ameliorative effect on migraine and associated headaches.’

Watson Headache® Approach could serve as a ‘bridge’ to assist migraineurs with medication withdrawal. It is possible that the observed events are a natural variation in the data, which might also explain the statistical significant difference seen between BL1 and BL2 for the wait list group for headache days every 28 days. A more plausible explanation for this, however, could be the anticipatory effect of future treatment.

The data broadly suggest that the Watson Headache® Approach for the treatment of migraine and other headaches shows promise. Given that the technique incorporates other interventions, such as exercise and advice, and that participants only had six sessions, the results of the present study could be a conservative estimate of its true effect. Although there is no conclusive evidence for physical interventions to the neck for the amelioration of migraine headache, there are some encouraging signs that physical treatment directed towards the neck may be effective. These include such modalities as spinal manipulation (Bronfort et al, 2001; Astin and Ernst, 2002; Schabert and Crow, 2009), acupuncture (Vickers et al, 2004; Linde et al, 2005; Wang and Young, 2011), massage (Lawler and Cameron, 2006; Chatchawan et al, 2014) and a combination of massage and spinal manipulation (Noudeh et al, 2012).

The mechanism by which physical treatment works is unclear; however, Vargas (2008) suggests that central sensitisation of the nervous system is a protagonist in the development of migraine. This sensitisation could be precipitated by hyper-excitability of pain-transmitting second-order neurones in the trigemino-cervical nucleus (TCN) caused by afferent input from dysfunctional cervical segments (Watson and Drummond, 2014) resulting in sensitisation of the trigeminal field through the nucleus caudalis (which has connections in the upper cervical spine). If sensitised, this can increase sensory traffic to the thalamus and cortex (Cady, 2007). As the trigeminal nerve supplies the meninges and its vascular structures, it is conceivable that sensitisation manifests itself as a pulsating headache.

Should neural sensitisation of the trigeminal nerve field and its associated connections be the culprit, one explanation as to why physical neck treatment is effective is that desensitisation occurs when a disrupting intervention to the cervical region reduces excessive neuronal signalling from the neck. This

‘The finding of this study adds to the body of evidence suggesting that treatment applied to the neck may ameliorate migraine and that the lessening of migraine following treatment has a lasting effect.’

may occur in manipulation, massage, acupuncture or mobilisation – all of which may have an inhibitory effect on the neuronal activity being transferred through the TCN, which acts as a conduit between the trigeminal nerve and the thalamus. This, however, is speculative.

Watson and Drummond (2012; 2014) have shown that mobilisation of the upper three cervical vertebrae appears to have an ameliorative effect on migraine (and associated headaches). However, this present study is the first to show this within the context of a pragmatic trial. The Watson Headache® Approach may be effective as it reproduces migraine (and other) headaches (including aura). Once produced, the manual pressure over the cervical vertebra is sustained.

The former allows for anatomical specificity of treatment and the latter, accommodation of the nociceptive afferent signals, thus leading to desensitisation and, it would appear, long-lasting effect. This combination of pressure and reproduction can be sustained for up to 90 seconds, during which the familiar headache should be produced and then lessened (Watson and Drummond, 2014). This lessening of pain/symptoms may be a marker for desensitisation of the trigeminal nerve field. The combination of these two key factors appears to be a unique element of the Watson Headache® Approach.

The linkage of tension type headache (a primary headache) and migraine headache has been put forward in the convergence or continuum theory (Schade, 1997; Cady et al, 2002; Cady, 2007; Vargas, 2008; Turner et al, 2015). Yet physical treatment for tension type headache may also include procedures that focus on the cervical area (Hammill et al, 1996; Chatchawan et al, 2014; France et al, 2014). Given the link between treatment for migraine and tension type headache, the prospect of the two having their genesis in the cervical spine is compelling for those who centre their treatment in this anatomical area.

The finding of this study adds to the body of evidence suggesting that treatment applied to the neck may ameliorate migraine and that the lessening of migraine following treatment has a lasting effect. It is possible, but by no means proven, that the sensitisation that is believed to be at the centre of migraine headache could be produced by unspecified pathology in the upper cervical spine. However, causality has yet to be demonstrated.

For many, self-medication remains the main treatment of choice, possibly due to its relatively low cost and convenience. Further endorsement of pharmaceutical solutions include botulinum toxin therapy for the relief of chronic migraine (Aurora et al, 2010; Diener et al, 2010), which is recommended under specific circumstances by the National Institute for Care and Clinical Excellence (2012). It is interesting to note that the placement of the injection needles for the delivery of botulinum toxin (and saline placebo) is similar to the locations used by manual therapists and acupuncturists. It is also interesting to note that the studies showed considerable reduction in migraine days for the control group as well as the intervention group (Aurora et al, 2010; Diener et al, 2010). It is possible that the success of the placebo control group was caused by a mechanical effect due to the insertion of the needle, a chemical effect of the saline, or both, resulting in the desensitisation of the TCN. Given the relatively high cost of botulinum toxin (Torgovnick, 2011), it is a wonder that saline is not used as a cheaper and safer first-line treatment.

Limitations

Despite the results, this present study has limitations. The most severe limitation was the attrition rate, which may have led to bias. If more patients who had perceived benefit from the treatment remained in the study, the data might be skewed in favour of the intervention, resulting in an overestimate of the treatment effect. This might suggest that the populations (those who continued in the study and those who dropped out) may be different. However, sensitivity analysis of mean headache score provides non-significant evidence that those who dropped out started with the highest headache scores, suggesting no significant difference between these subgroups at baseline. This alleviates some concerns that the characteristics of those who dropped out differed significantly to participants retained on the study.

A cogent reason for attrition following a single treatment may have been replication of the migraine symptoms during treatment, despite participants being warned of this in the patient information sheet. This reaction is understandable, as it runs counter to most treatment interventions that seek to avoid the reproduction of symptoms. It is more difficult to explain why 25 participants who received treatment did not provide any post-treatment data. It is possible that people saw this as an opportunity to receive treatment not normally routinely provided in the public sector and were not otherwise committed to the study. To mediate against this potential problem, future studies might consider it prudent to offer an ethically-sound inducement to participants to ensure complete data collection post-treatment.

The wait list control was also a potential problem, in that it only allowed a single point in time when between-group analysis could be assessed. Future studies should be comparative in nature in order that follow-up comparisons can be made throughout the entire follow-up period.

A further problem of this present study was very slow recruitment. De Hertaogh et al (2009) have identified the difficulties in recruitment associated with this kind of study. Despite recruiting from many sources, uptake was extremely slow. After 5 years of recruitment, despite considerable interest in the study only 101 patients gave consent and provided baseline data. The reason for this remains unknown, but perhaps the study seemed too arduous or the inducement of headache during assessment and treatment deterred participants. Further work should explore this.

CONCLUSIONS

Although limited by a small sample size, this study has provided some evidence to support the use of the Watson Headache® Approach for the treatment of headaches, including migraine. This further supports the theory that migraine headaches have their genesis in the upper cervical spine. Although the within-group evidence consistently points to a continued effect, more work is required – particularly in the form of a fully-powered placebo controlled comparative RCT conducted nationally or internationally.

Mobilisation seemed to produce an effect worthy of further investigation. In a future trial, the sample size could be larger than expected if the headache score is retained as the primary outcome measure. The use of a wait list group has some value but is unable to give between-group analysis throughout follow-up in the way that a fully powered comparative study could. Finally, the acceptability of this treatment is not universal, as evidenced by the low uptake and high attrition rate. However, it is clear that this treatment could be effective for some.

For those who are able and willing to engage with this approach, the outcome appears broadly positive. Future studies should investigate who is most likely to benefit and who may be at greater risk of potential side-effects. The theory that the Watson Headache® Approach could be used as a 'bridge' to reduce medication use, and so minimise medication overuse, may warrant further investigation. **IJTR**

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